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(54) A rotary transmission

(57) The transmission provides a series of increasing speed ratios and includes two clutches 13, 14 independently operable to provide increasing forward drive paths through gearing between an input shaft 10 and output shafts 47, 48. The gearing for the ratios is driven respectively through one and then the other clutch. Selector means A—G is provided for selecting a plurality of forward ratios and a plurality of reverse ratios. Preferably, with given forward and reverse ratios selected, a change from forward drive to reverse drive can be effected by driving through said one clutch then the other clutch.

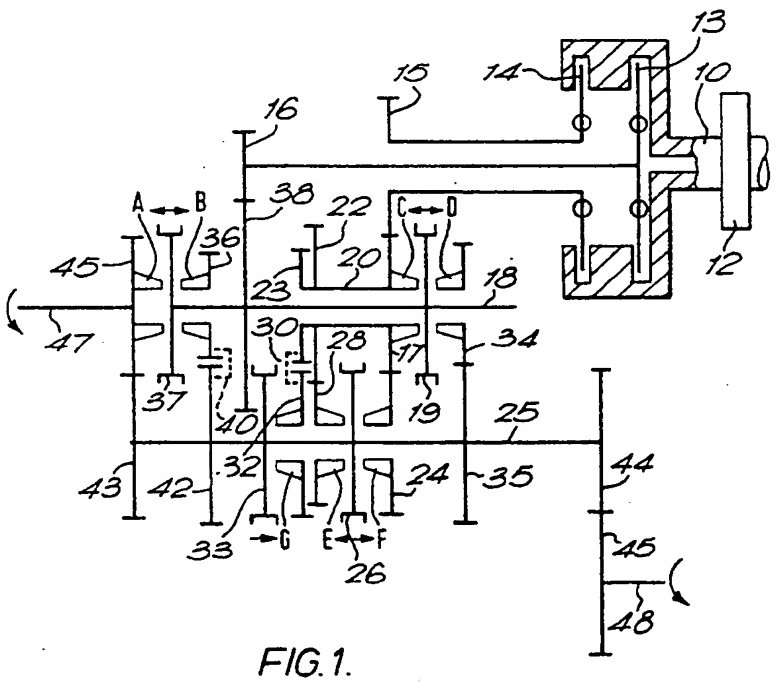

FIG. 1.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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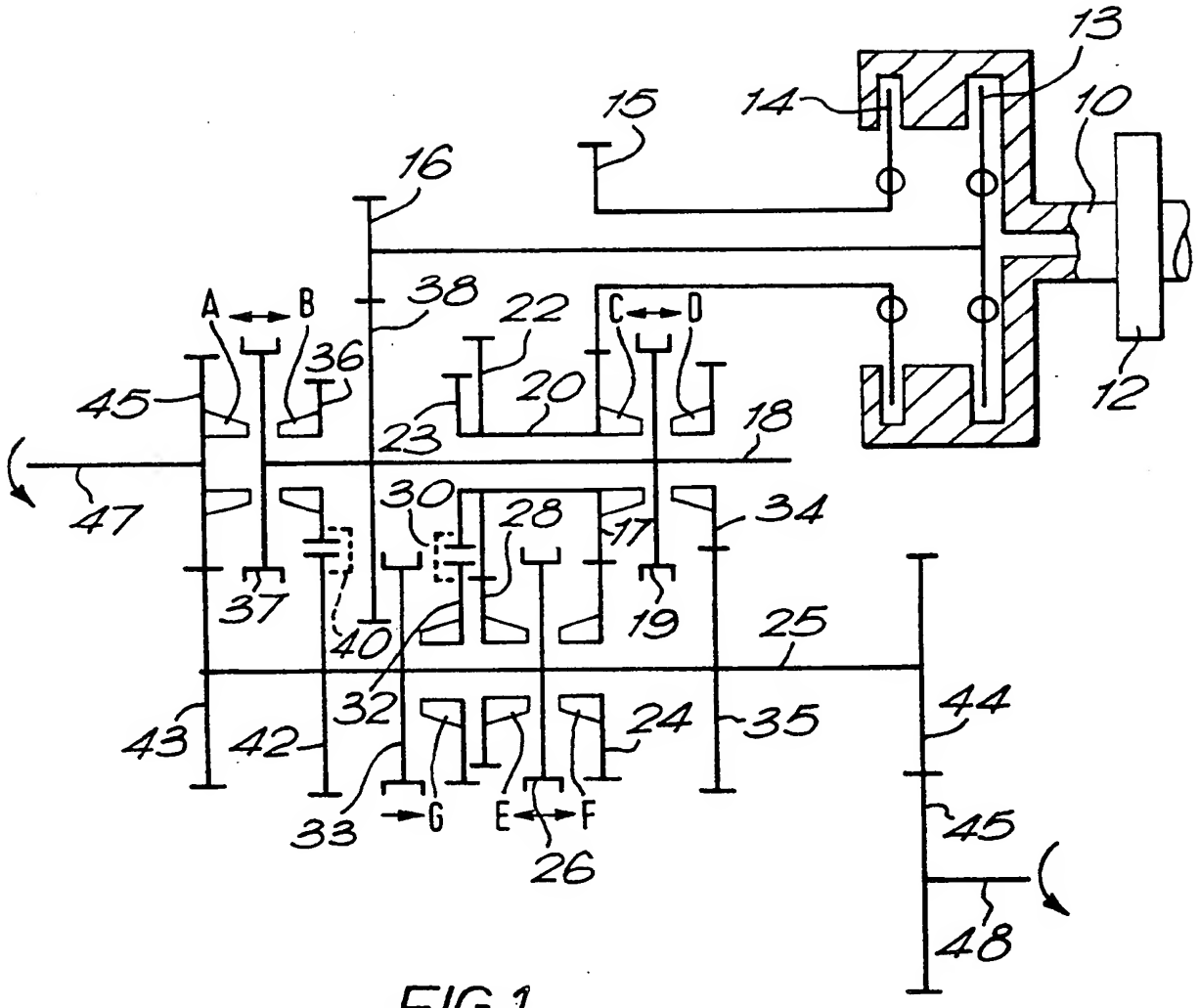

FIG. 1.

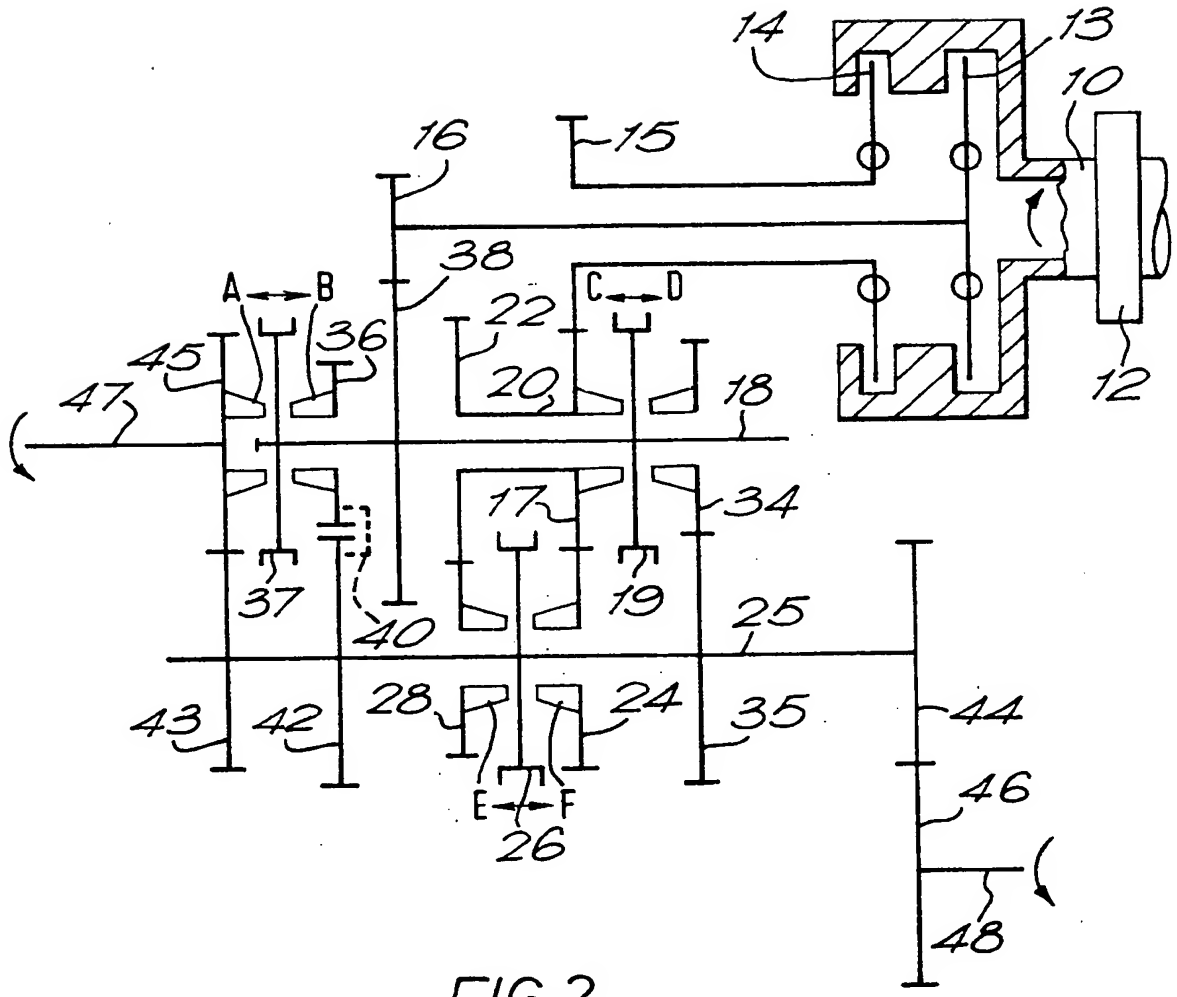

FIG.2.

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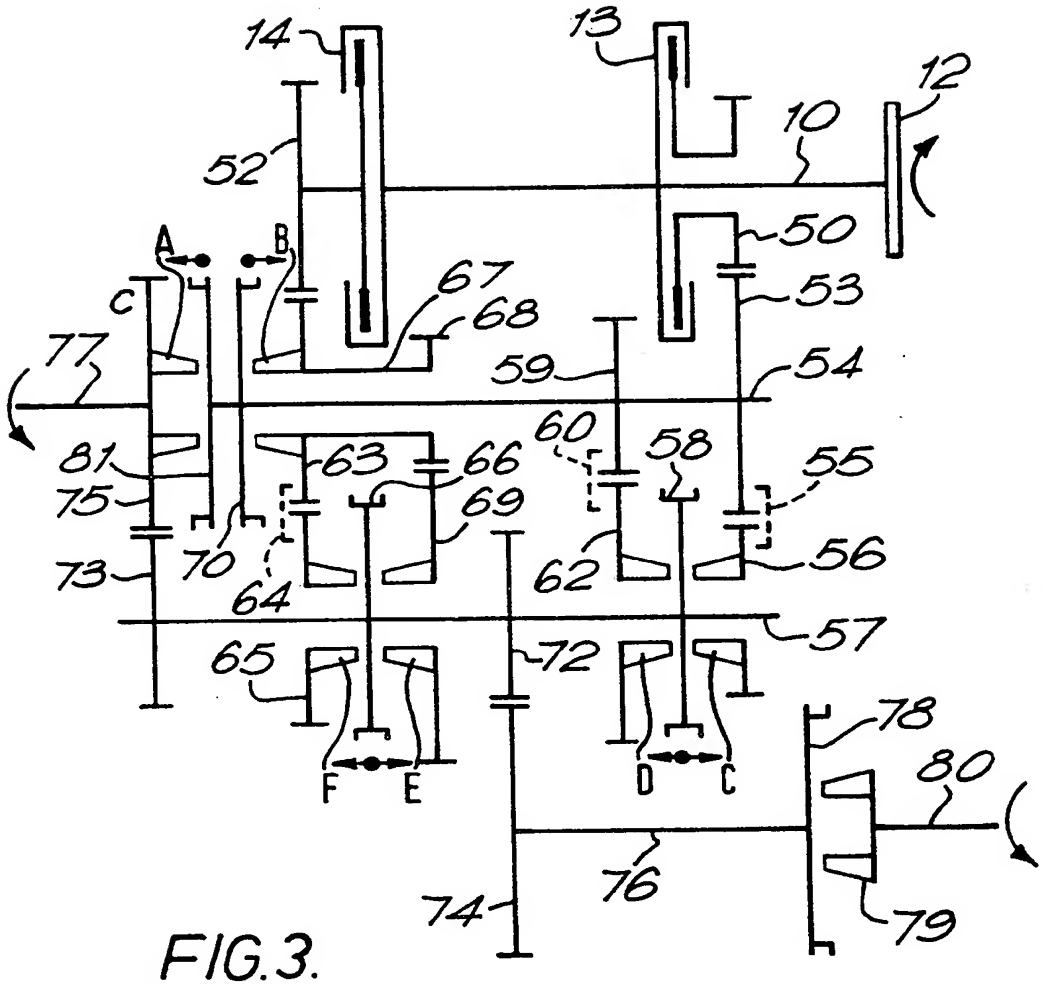

FIG.3.

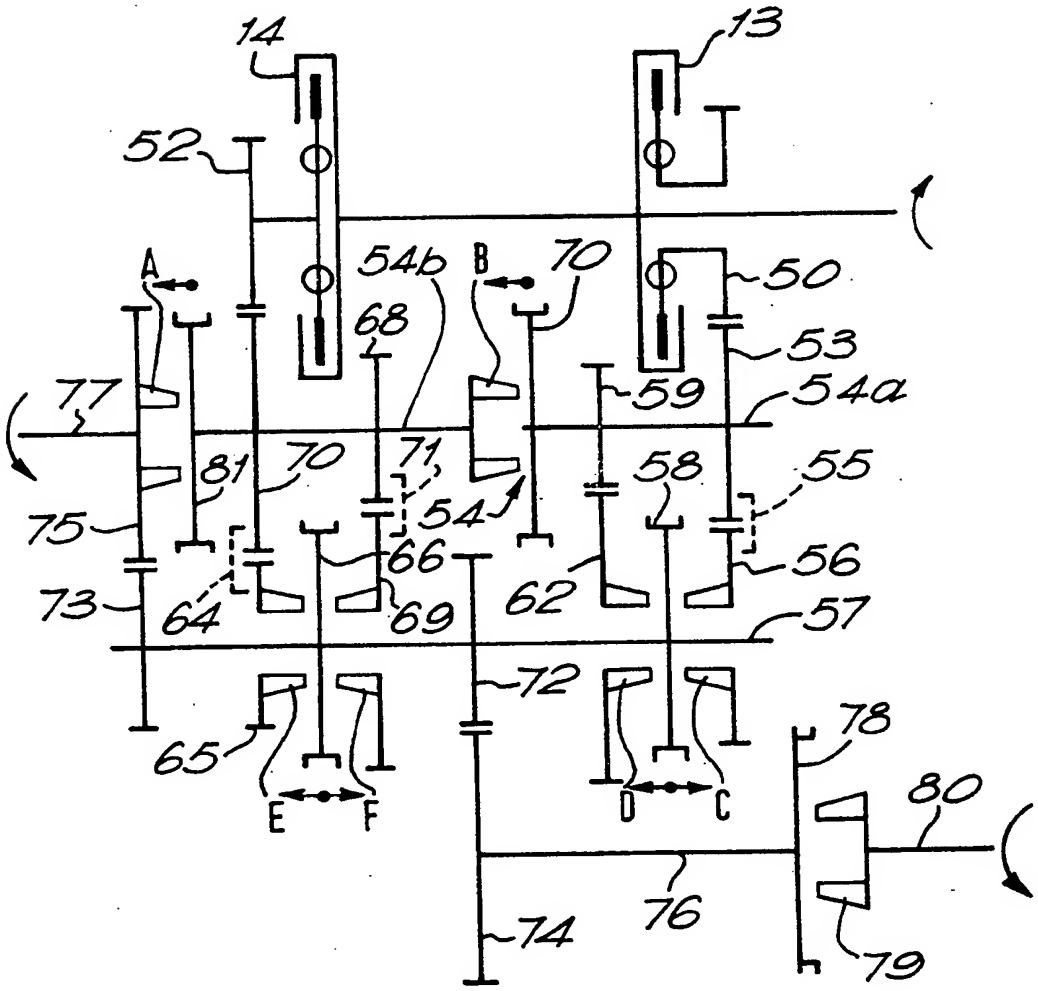

FIG.4.

SPECIFICATION

A Rotary Transmission

The invention relates to a rotary transmission which is particularly, but not exclusively, for installation in an off-road vehicle such as digging vehicle, dumper or the like.

According to one aspect of the invention there is provided a rotary transmission providing a series of increasing speed ratios and two clutches independently operable and provides increasing forward drive paths through gearing between an input shaft and an output shaft, the gearing for the ratios being driven respectively through one and the other clutch, and selector means for selecting a plurality of forward ratios and a plurality of reverse ratios whereby with given forward and reverse ratios selected a change from forward drive to reverse drive can be effected by driving through said one and then the other clutch.

Such an arrangement is advantageous as the plurality of reverse ratios enables the vehicle to be particularly versatile, a useful feature in off-road applications. Also the ability to alternate between forward and reverse drives enables the driver to switch rapidly between forward and reverse simply by actuating the clutches alternately. Such operation of the transmission can be used e.g. to rock the vehicle back and forth to free it from safe ground into which the wheels have sunk.

Preferably a change from forward to reverse drive by driving through said one and then the other clutch can be achieved between a plurality of said forward ratios and a plurality of said reverse ratios. That arrangement increases further the versatility of the vehicle giving the facility for rapid switching between, e.g. a second forward ratio and a first reverse ratio, and a third forward ratio and a second reverse ratio.

A first layshaft may carry a drive gear wheel for reverse drive in constant mesh with an idler gear. Preferably said first layshaft carries a gear wheel which meshes with a gear wheel on a second layshaft. The second layshaft may carry gearing in mesh with gearing on said output shaft.

According to another aspect of the invention there is provided a rotary transmission providing a series of increasing speed ratios and two clutches independently operable and providing increasing forward drive paths through gearing between an input shaft and an output shaft, the gearing for the ratios being driven respectively through one and then the other clutch, the transmission including a first layshaft carrying a reverse drive gear wheel in constant mesh with an idler gear for transmission of reverse drive for said input shaft to the output shaft, said first layshaft carrying a gear wheel which meshes with a gear wheel on a second layshaft said second layshaft carrying gearing in mesh with gearing on said output shaft.

Preferably selector means are provided for selecting forward and reverse ratios and are arranged whereby with given forward and reverse ratios selected, a change from forward drive to reverse drive can be effected by driving through one and then the other clutch.

Preferably, the gearing of said other aspect of the invention provides a plurality of reverse ratios.

Where the rotary transmission provides a plurality of reverse ratios, it is preferred that drive in one of said reverse ratios is transmitted from said one clutch and drive in another of said reverse ratios is transmitted from said other clutch.

Preferably said first layshaft carries a plurality of reverse drive gear wheels in constant mesh with respective idler gears. Each idler gear may be in constant mesh with a respective gear which is selectively drivably connectable to the second layshaft.

Selector means may be provided for drivably connecting said output shaft directly to said first layshaft.

If desired, the first layshaft may comprise a plurality of shaft sections.

In the case where the first layshaft carries a plurality of reverse drive gear wheels, at least one of said reverse drive gear wheels may be carried by one of said shaft sections. Said shaft sections may be selectively drivably interconnectable by selector means.

A said reverse drive gear wheel may be rotatably fast with a sleeve having a gear wheel rotatably fast therewith in mesh with a gear wheel on said second layshaft.

To enable e.g. a four wheel drive to be achieved, a plurality of output shafts may be provided.

Rotary transmissions for vehicles in accordance with the invention will now be described by way of example with reference to the accompanying drawings in which:

Fig 1 illustrates one type of change speed transmission in accordance with the invention for a vehicle.

Fig. 2 illustrates a variation of the transmission of Fig. 1.

Fig. 3 illustrates another type of change speed transmission in accordance with the invention, and

Fig. 4 illustrates a variation of the transmission of Fig. 1,3.

Referring first to Fig. 1, an input shaft 10 is driven from a torque converter 12 which is itself driven by van engine (not shown). The input shaft 10 is connectable through first and second clutches 13, 14 to first and second input gear wheels 15, 16 respectively. It is intended that the operation of the clutches 13, 14 in this embodiment and those in Figs. 2, 3 and 4 will be in response to an electro-hydraulic automatic control system (not shown). A pump (not shown) to provide hydraulic fluid under pressure to such an electro-hydraulic control system may be conveniently driven from the input shaft 10. The first gear wheel 15 meshes with a gear wheel 17 which is rotatably mounted on a first layshaft 18 and selectively drivably connectable thereto by a sliding member 19 and synchronizer C. The gear wheel 17 has a sleeve 20 rotatably fast therewith and which carries a further gear wheel 22 and a reverse drive gear wheel 23. The gear wheel 17 meshes with a gear wheel 24 which is rotatably mounted on a second layshaft 25 and selectively drivably connectable thereto by a sliding member 26 and a synchronizer F. The gear wheel 22

meshes with a gear wheel 28 which is selectively drivably connectable to the second shaft 25 by the sliding member 26 and synchronizer E. The reverse drive gear 23 meshes constantly with a lay gear shown diagrammatically at 30 which is also in mesh with a gear wheel 32 rotatably mounted on second shaft 25 and selectively drivably connectable thereto by a sliding member 33 and a synchronizer G. A further gear wheel 34 is rotatably mounted on the first shaft 18 and is selectively drivably connectable thereto by the sliding member 19 and a synchronizer D. The gear wheel 34 meshes with a gear wheel 35 rotatably fast with the second shaft 25. The shaft 18 also rotatably carries a second reverse drive gear 36 which is selectively drivably connectable to the shaft 18 by a sliding member 37 and a synchroniser B. The gear wheel 36 meshes constantly with a lay gear shown diagrammatically at 40 which in turn meshes with a gear wheel 42 rotatably fast with the second shaft 25. The shaft 25 is rotatably fast with two further gears 43, 44 which mesh with output gear wheels 45, 46 on output shafts 47, 48 respectively for transmitting drive to respective sets of differential gearing to enable drive to be transmitted to four wheels of a vehicle. The shafts 18, 47 can be drivably interconnected by sliding member 37 and a synchronizer A.

The second input gear wheel 16 meshes with a gear wheel 38 rotatably fast with the shaft 18.

The operation of the transmission to drive the output-shafts 47, 48 is as follows:

With the vehicle engine running, both clutches 13, 14 are initially disengaged and the various sliding members are in their neutral positions disengaged from associated synchronizers.

To move off from rest in first ratio, sliding members 19, 26 are shifted to engage synchronizers C, F, clutch 13 is engaged and drive is transmitted through gear wheels 16,38; 17,24; 43,45 and 44,46.

Second ratio is selected by simultaneously engaging clutch 14 and disengaging clutch 13 so that drive is then transmitted throough gear wheels 15,17; 17,24; 43,45 and 44,46.

Third ratio is preselected by moving sliding member 19 to the right so as to engage synchronizer D whereby clutch 13 is driven idly. Drive is then transmitted in third ratio by engaging clutch 13 and simultaneously disengaging clutch 14 so that drive is transmitted through gear wheels 16,38; 34,35; 43,45 and 44,46.

Fourth ratio is preselected by shifting sliding member 26 to engage synchronizer E whereby clutch 14 is driven idly. Drive in fourth ratio is then transmitted by engaging clutch 14 and simultaneously disengaging clutch 13 to transmit drive through gear wheels 15,17; 22,28; 43,45 and 44,46.

Fifth ratio is preselected by shifting sliding member 37 to engage synchronizer A so that clutch 13 is driven idly. Drive is then transmitted in fifth ratio by engaging clutch 13 and simultaneously disengaging clutch 14 so that drive is transmitted to gear wheels 16,38 and directly from first shaft 18 to the output shaft 47 and through gear 45,43 and 44,46 to the output shaft 48.

Sixth ratio is preselected by shifting sliding member 19 into engagement with synchronizer C so that clutch 14 is driven idly.

Drive in sixth ratio is then transmitted by engaging clutch 14 and simultaneously disengaging clutch 13 so that drive is transmitted through gear wheels 15,17, shaft 18 through to output shaft 47 and through gear wheel 45,43; and 44,46 to the output shaft 48.

It is possible to select four reverse ratios with the gearing illustrated in Fig. 1 and selection of reverse ratios is described as follows:

For first reverse ratio, sliding member 19 is shifted to engage synchronizer C and sliding member 33 is shifted to engage synchronizer G. Clutch 13 is engaged and clutch 14 is simultaneously disengaged (if clutch 14 was previously in a drive transmitting condition), whereby drive is transmitted through gear wheels 16,38; 23,30; 30,32; 43,45; and 44,46.

Second reverse ratio is obtained by engaging clutch 14 and simultaneously disengaging clutch 13 so that drive is transmitted through gear wheels 15,17; 23,30; 30,32; 43,45 and 44,46.

Third reverse ratio can be preselected by shifting sliding member 37 to engage synchronizer B so that clutch 13 is driven idly. Drive is then transmitted in third reverse ratio by engaging clutch 13 and simultaneously disengaging clutch 14 so that drive is transmitted through gear wheels 16,38; 36,40; 40,42; 43,45 and 44,46.

Fourth reverse ratio can be preselected by shifting sliding member 19 to engage synchronizer C so that clutch 14 is driven idly. Drive in fourth reverse ratio is then transmitted by engaging clutch 14 and simultaneously disengaging clutch 13 so that drive is transmitted through gear wheels 15,17; 36,40; 40,42; 43,45 and 44,46.

The various ratios selectable and the synchronizers, gearing and clutches used are conveniently set out in the table below.

Ratio	Synchronizer	Gear Wheel Transmitting Drive	Clutch
1	C,F	16/38.17/24.43/45.44/46	13
2	F	15/17.17/24.43/45.44/46	14
3	D	16/38.34/35.43/45.44/46	13
4	E	15/17.22/28.43/45.44/46	14
5	A	16/38.45/43.44/46	13
6	C,A	15/17.45/43.44/46	14
R1	C,G	16/38.23/30.30/32.43/45.44/46	13
R2	G	15/17.23/30.30/32.43/45.44/46	14
R3	B	16/38.36/40.40/42.43/45.44/46	13
R4	C,B	15/17.36/40.40/42.43/45.44/46	14

Fig. 2 illustrates a variation of the transmission shown in Fig. 1 and provides six forward ratios and two reverse ratios. It will be apparent that the gearings are identical except that the gear wheels 23,30 and 32, sliding member 33 and synchronizer G are not present in Fig. 2. Components corresponding to components in Fig. 1 carry the same reference numerals and the various ratios selectable and the synchronizers, gearing and clutches used are conveniently set out in the table below

Ratio	Synchronizer	Gear Wheels Transmitting Drive	Clutch
1	C;F	16/38.17/24.43/45.44/46	13
2	F	15/17.17/24.43/45.44/46	14
3	D	16/38.34/35.43/45.44/46	13
4	E	15/17.22/28.43/45.44/46	14
5	A	16/38.45/43.44/46	13
6	C,A	15/17.45/43.44/46	14
R1	B	16/38.36/40.40/42.43/45.44/46	13
R2	C,B	15/17.36/40.40/42.43/45.44/46	14

In Fig. 3 an input shaft 10 is driven from a torque converter 12 as in Figs. 1 and 2. The input shaft 10 is connectable through clutches 13,14 to first and second input gear wheels 50,52 respectively. The first gear wheel 50 meshes with a reverse drive gear wheel 53 rotatably fast with a first shaft 54. The gear wheel 53 meshes constantly with a lay gear shown diagrammatically at 55 which meshes with a gear wheel 56 rotatably mounted on a second shaft 57. The gear wheel 56 is selectively drivably connectable to the shaft 57 by a sliding member 58 and a synchronizer C.

The shaft 54 is rotatably fast with another reverse drive gear wheel 59 which meshes constantly with a lay gear shown diagrammatically at 60 in mesh with a gear wheel 62 rotatably mounted on shaft 57. The gear wheel 62 is selectively drivably connectable to the shaft 57 by said sliding member 58 and a synchronizer D. Gear wheel 52 meshes with a further reversing gear wheel 63 which meshes with a lay gear 64 in mesh with a gear wheel 64 rotatably mounted on shaft 57. The gear wheel 64 is selectively drivably connectable to the shaft 57 by a sliding member 66 and a synchronizer F. The gear wheel 62 is rotatably fast with a sleeve 67 which is rotatably fast with a further gear wheel 68 in mesh with a gear wheel 69 rotatably mounted on shaft 57. The gear wheel 69 is selectively drivably connectable to the shaft 57 by said sliding member 66 and a synchronizer E. The sleeve 67 is selectively drivably connectable to shaft 54 by a sliding member 70 and a synchronizer B.

Shaft 57 is rotatably fast with two gear wheels 72,73 which mesh with respective output gear wheel 74,75 rotatably fast with output shafts 76,77. Output shaft 76 is selectively drivably connectable by a sliding member 78 and synchronizer 78 to a differential gearing drive shaft 79. Output shaft 77 is also arranged to

drive a differential gearing and is selectively drivably connectable to shaft 54 by means of a sliding member 82 and a synchronizer A.

The operation of the transmission to drive the output shafts 76,77 is as follows:

With the vehicle engine running, both clutches 13,14 are initially disengaged and the various sliding members are in the neutral positions disengaged from associated synchronizers.

To move off from rest in first ratio sliding members 70,66 are shifted to engage synchronizers B,E, clutch 13 is engaged and drive is transmitted through gears 50,53; 68,69; 73,75 and 72,74.

Second ratio is selected by simultaneously engaging clutch 14 and disengaging clutch 13 so that drive is then transmitted through gear wheels 52,63; 68,69; 73,75 and 72,74.

Third ratio is preselected by shifting sliding member 81 to the left to engage synchronizer A whereby clutch 13 is driven idly. Drive is then transmitted in third ratio by engaging clutch 13 and simultaneously disengaging clutch 14, so that drive is then transmitted through gears 50,53 directly to the output shaft 77 and through gears 75,73; 72,74 to output shaft 76.

Fourth ratio is preselected by shifting sliding member 70 to the right to engage synchronizer B. Drive is then transmitted in fourth ratio by engaging clutch 14 and simultaneously disengaging clutch 13 so that drive is transmitted through gears 52,63; 75,73 and 72,74.

It is possible to select three reverse ratios with the Fig. 4 gearing and selection of those ratios is described as follows:

For first reverse ratio sliding member 58 is shifted to the left to engage synchronizer D. Clutch 13 is engaged and clutch 14 is simultaneously disengaged (if clutch 14 was previously in a drive transmitting condition) whereby drive is transmitted through gear wheels 50,53; 59,60; 60,62; 73,75 and 72,74.

Second reverse ratio can be preselected by shifting sliding member 66 to the left to engage synchronizer F so as to drive clutch 14 idly. Drive in second reverse ratio is then transmitted by engaging clutch 14 and simultaneously disengaging clutch 13 whereby drive is transmitted through gear wheels 52,63; 63,64; 64,65; 73,75 and 72,74.

Third reverse ratio can be preselected by shifting sliding member 58 to the right to engage synchronizer C. Drive in third reverse ratio is then obtained by engaging clutch 13 and simultaneously disengaging clutch 14 whereby drive is transmitted through gear wheels 50,53; 53,55; 55,56; 73,75 and 72,74.

The transmission in Fig. 2 is advantageous as it enables a change from forward to reverse to be made rapidly by simply alternating drive from clutch 13 to clutch 14. This can assist when manoeuvring the vehicle or when rapid forward and reverse movement is otherwise necessary. Such rapid change can be made between ratio 2 and R1 and between ratio 3 and R2.

To alternate between 2 and R1 synchronizer E is engaged for ratio 2 and synchronizer D for R2. When driving in ratio 2 through clutch 14 clutch 13 will be driven idly through gears 62,60; 60,59 and 53,50.

After switching to clutch 13 and simultaneously disengaging clutch 14 to obtain R1, clutch 14 is driven idly by gears 69,68 and 63,52.

A similar rapid change can be made between ratio 3 to R2. To alternate between 3 and R2, synchronizer A is engaged for ratio 3 and synchronizer F is engaged for ratio R2. When driving in ratio 3 through clutch 13, clutch 14 is driven idly through gears 75,73; 65,64; 64,63 and 63,52. After switching to clutch 14 and simultaneously disengaging clutch 13 to obtain R2, clutch 13 is driven idly by gears 53,50.

The various ratios selectable with the Fig. 3 transmission and the synchronizers, gearing and clutches used are conveniently set out in the table below.

Ratio	Synchronizer	Gear Wheel Transmitting Drive	Clutch
1	B,E	50/53.68/69.73/75.72/74	13
2	E	52/63.68/69.73/75.72/74	14
3	A	50/53.75/73.72/74	13
4	A,B	52/63.75/73.72/74	14
R1	D	50/53.59/60.60/62.73/75.72/74	13
R2	F	52/63.63/64.64/65.73/75.72/74	14
R3	C	50/53.53/55.55/56.73/75.72/74	13

Fig. 4 illustrates variation of the transmission shown in Fig. 3. The variation takes place along layshaft 54 which now comprises two sections 54a, 54b which can be selectively drivably interconnected by the sliding member 70 and synchronizer B which are re-located. The sleeve 67 is omitted and the gear wheel 63,69 are now rotatably fast with shaft 54b. Gear wheel 68 now meshes with a lay gear 71 in mesh with gear 69 and gear wheel 59 meshes directly with gear wheel 62.

All parts in Fig. 4 corresponding to parts in Fig. 3 carry the same reference numerals and the various ratios selectable and the synchronizers, gearing and clutches used are conveniently set out in the table below.

Ratio	Synchronizer	Gear Wheels Transmitting Drive	Clutch
1	B,D	52/63.59/62.73/75.72/74	14
2	D	50/53.59/62.73/75.72/74	13
3	A	52/63.75/73.72/74	14
4	A,B	50/53.75/73.72/74	13
R1	E	52/63.68/71.71/69.73/75.72/74	14
R2	C	50/53.53/55.55/56.73/75.72/74	13
R3	F	52/63.63/64.64/65.73/75.72/74	14

Changes from forward to reverse can be made rapidly in the Fig. 4 transmission, the same as in Fig. 3 by alternating engagement of clutches 13,14 between ratios 2 and R1 with the synchronizers for those ratios pre-engaged. Similar rapid changes can be made between ratios 3 and R2.

Preferably the ratios of the gearing providing forward ratios 2 and 3 are the same as those of the gearing providing reverse ratios R1 and R2 in Figs. 3 and 4.

Ratio downchanges are made in reverse manner to ratio upchanges.

CLAIMS

1. A rotary transmission providing a series of increasing speed ratios and two clutches independently operable and providing increasing forward drive paths through gearing between an input shaft and an output shaft the gearing for the ratios being driven respectively through one and the other clutch and selector means for selecting a plurality of forward ratios and a plurality of reverse ratios whereby with given forward and reverse ratios selected a change from forward drive to reverse drive can be effected by driving through said one and then the other clutch.

2. A rotary transmission according to Claim 1 in which a change from forward to reverse drive by driving through said one and then the other clutch can be achieved between a plurality of said forward ratios and a plurality of said reverse ratios.

3. A rotary transmission according to Claim 1 or 2 in which a first layshaft carries a drive gear wheel for reverse drive in constant mesh with an idler gear.

4. A rotary transmission according to Claim 3 in which said first layshaft carries a gear wheel which meshes with a gear wheel on a second layshaft.

5. A rotary transmission according to Claim 4 in which said second layshaft carries gearing in mesh with gearing on said output shaft.

6. A rotary transmission providing a series of increasing speed ratios and two clutches independently operable and providing increasing forward drive paths through gearing between an input shaft and an output shaft, the gearing for the ratios being driven respectively through one and then the other clutch, the transmission including a first layshaft carrying a reverse drive gear wheel in constant mesh with an idler gear for transmission of reverse drive for said input shaft to the output shaft said first layshaft carrying a gear wheel which meshes with a gear wheel on a second layshaft, said second layshaft carrying gearing in mesh with gearing on said output shaft.

7. A rotary transmission according to Claim 6 in which selector means are provided for selecting forward and reverse ratios and are arranged whereby with given forward and reverse ratios selected, a change from forward drive to reverse drive can be effected by driving through one and then the other clutch.

8. A rotary transmission according to any of Claims 6 to 7 in which the gearing provides a plurality of reverse ratios.

9. A rotary transmission according to any preceding claim and where the gearing provides a plurality of reverse ratios, in which drive in one of said reverse ratios is transmitted from said one clutch and drive in another of said reverse ratios is transmitted from said other clutch.

10. A rotary transmission according to any of Claims 2 to 9 in which said first layshaft carries a plurality of reverse drive gear wheels in constant mesh with respective idler gears.

11. A rotary transmission according to Claim 10 in which each idler gear is in constant mesh with a respective gear which is selectively drivably connectable to the second layshaft.

12. A rotary transmission according to any of Claims 3 to 11 in which selector means is provided for drivably connecting said output shaft directly to said first layshaft.

13. A rotary transmission according to any of Claims 3 to 12 in which said first layshaft comprises a plurality of shaft sections.

14. A rotary transmission according to Claim 13 and in the case where the first layshaft carries a plurality of reverse drive gear wheels, in which at least one of said reverse drive gear wheels is carried by one of said shaft sections.

15. A rotary transmission according to Claim 13 or 14 in which said shaft sections are selectively drivably interconnectable by selector means.

16. A rotary transmission according to any of Claims 4 to 15 in which a said reverse drive gear wheel is rotatably fast with a sleeve having a gear wheel rotatably fast therewith in mesh with a gear wheel on said second layshaft.

17. A rotary transmission according to any preceding claim in which a plurality of output shafts is provided.

18. A rotary transmission constructed and arranged substantially as described herein with reference to Fig. 1, 2, 3 or 4 of the accompanying drawings.

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